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(54) APPARATUS AND METHOD OF SEARCHING FOR DNS SERVER IN OUTERNET

(75) Inventors: **Hyun-seok Choi**, Seoul (KR); **Chul-min Kim**, Suwon-si (KR); **Young-geun Kim**, Incheon Metropolitan (KR)

Correspondence Address:
SUGHRUE MION, PLLC
2100 Pennsylvania Avenue, NW
Washington, DC 20037-3213 (US)

(73) Assignee: **SAMSUNG ELECTRONICS CO., LTD.**

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(52) **U.S. Cl.** **707/3**

(57) **ABSTRACT**

Outernet DNS searching units are included in a host, a DNS server, a router where a DNS server is registered, and a router where a DNS server is not registered, allowing Internet-enabled terminals to automatically search for a DNS server in an outernet. The host creates a DNS search message and transmits it to a subnet to which the host belongs so as to receive a response message. If no response message is received from the subnet (i.e., a DNS server is not connected to the subnet), the DNS search message is transmitted to an outernet to which the host does not belong, to which a DNS server is connected. Further, when a DNS server does not respond to a DNS search message from a host, a hop limit is increased to resend the DNS search message, thereby preventing waste of network bandwidth and easily detecting the closest DNS server.

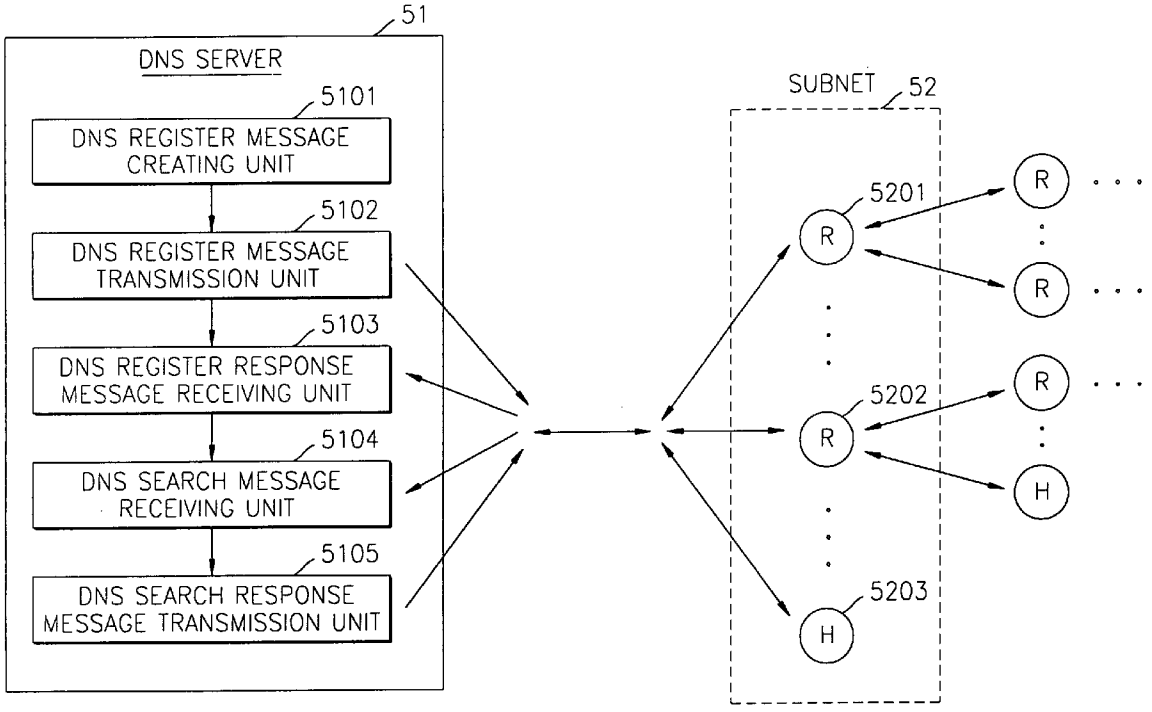


FIG. 1

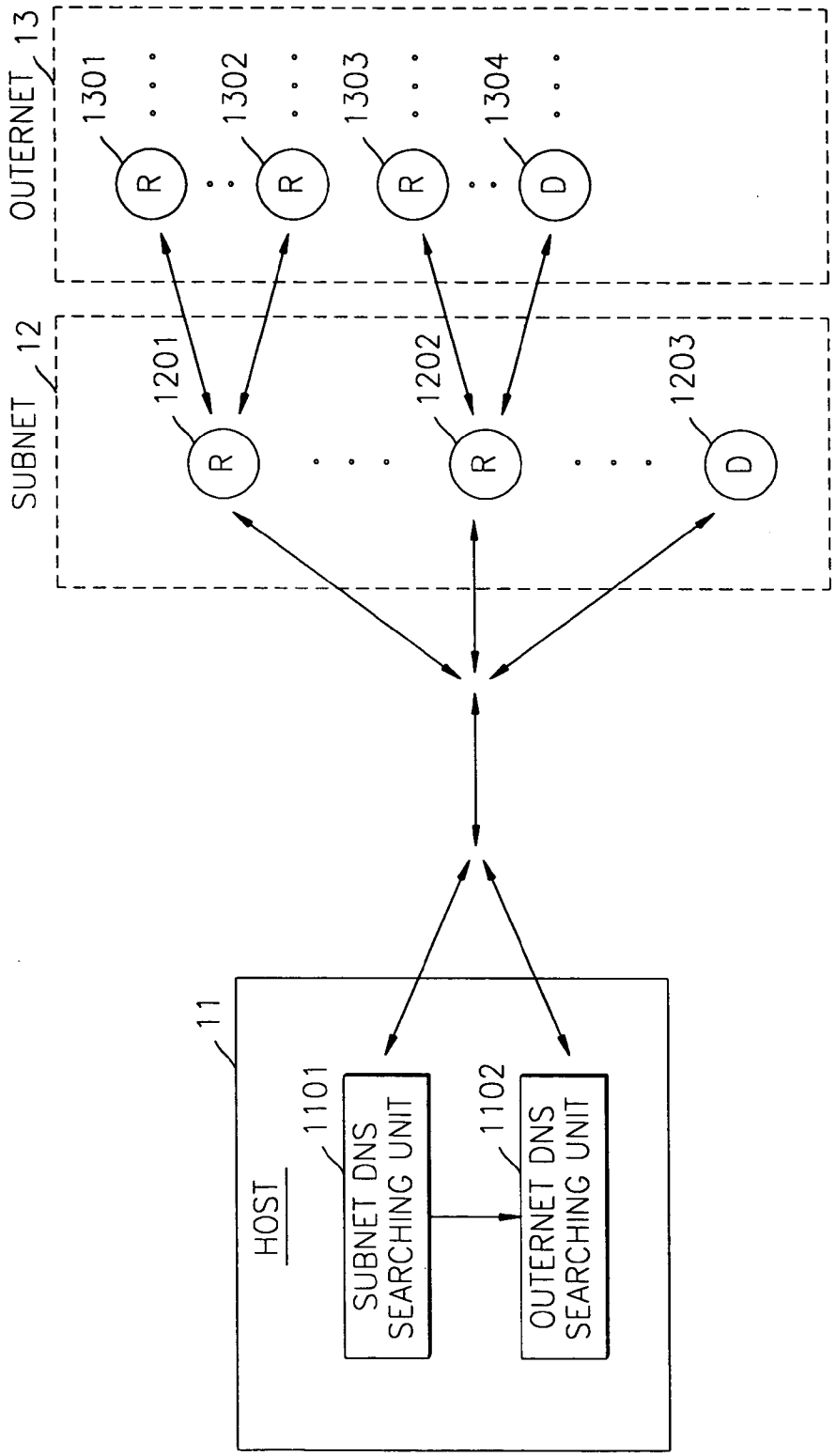

OUTERNET 13
1301
1302
1303
1304
R
R
R
D
SUBNET 12
1201
1202
1203
R
R
D
11
HOST
1101
SUBNET DNS SEARCHING UNIT
1102
OUTERNET DNS SEARCHING UNIT

FIG. 2

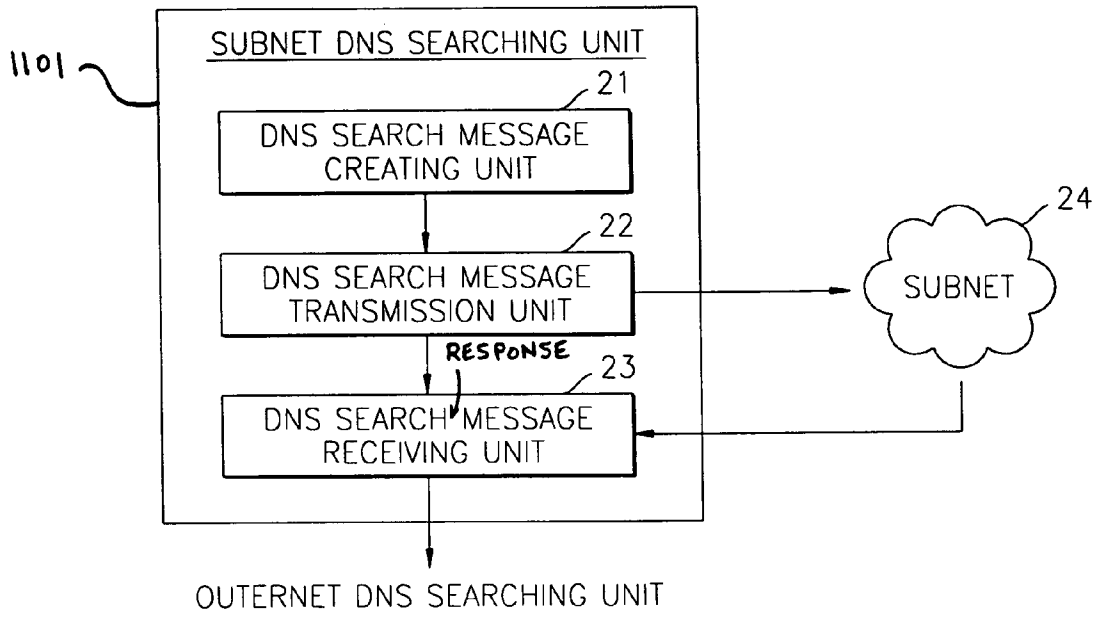

1101
SUBNET DNS SEARCHING UNIT
21
DNS SEARCH MESSAGE CREATING UNIT
22
DNS SEARCH MESSAGE TRANSMISSION UNIT
RESPONSE
23
DNS SEARCH MESSAGE RECEIVING UNIT
24
SUBNET
OUTERNET DNS SEARCHING UNIT

FIG. 3

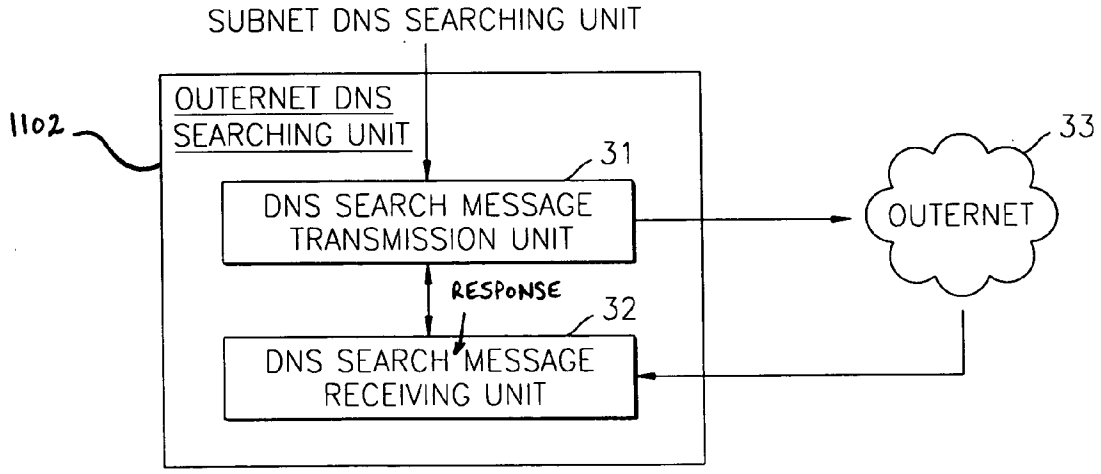

SUBNET DNS SEARCHING UNIT
1102
OUTERNET DNS SEARCHING UNIT
31
DNS SEARCH MESSAGE TRANSMISSION UNIT
RESPONSE
32
DNS SEARCH MESSAGE RECEIVING UNIT
33
OUTERNET

FIG. 4

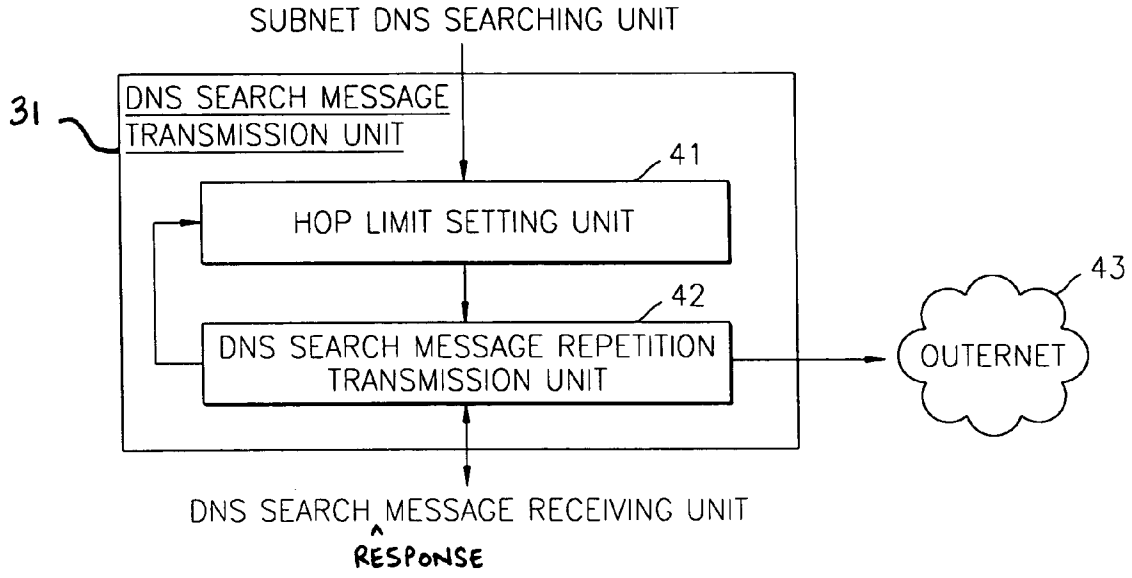

SUBNET DNS SEARCHING UNIT
31
DNS SEARCH MESSAGE TRANSMISSION UNIT
41
HOP LIMIT SETTING UNIT
42
DNS SEARCH MESSAGE REPETITION TRANSMISSION UNIT
43
OUTERNET
DNS SEARCH MESSAGE RECEIVING UNIT
RESPONSE

FIG. 5

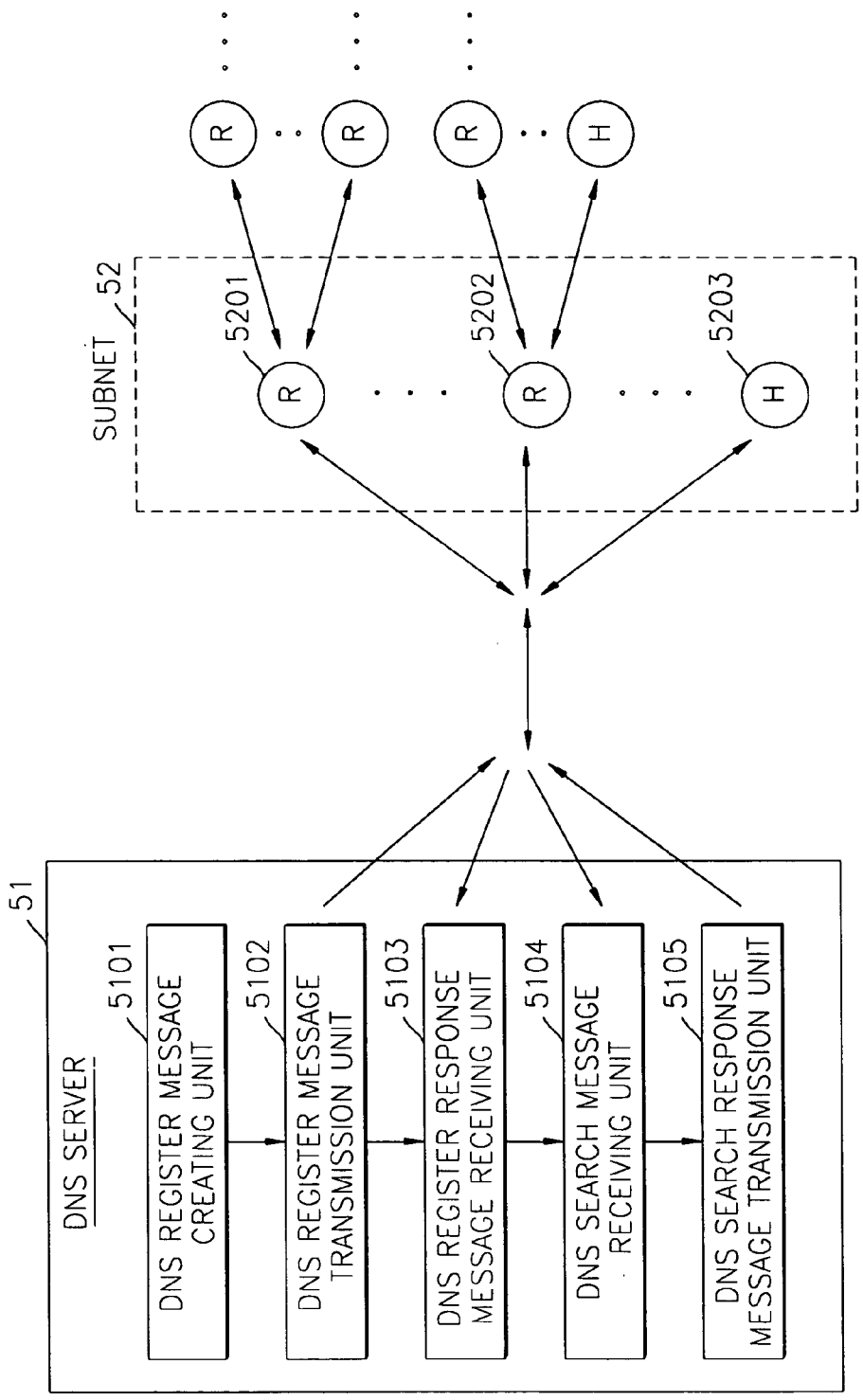

R
R
R
H
SUBNET
52
5201
5202
5203
R
R
H
51
DNS SERVER
5101
DNS REGISTER MESSAGE CREATING UNIT
5102
DNS REGISTER MESSAGE TRANSMISSION UNIT
5103
DNS REGISTER RESPONSE MESSAGE RECEIVING UNIT
5104
DNS SEARCH MESSAGE RECEIVING UNIT
5105
DNS SEARCH RESPONSE MESSAGE TRANSMISSION UNIT

FIG. 6

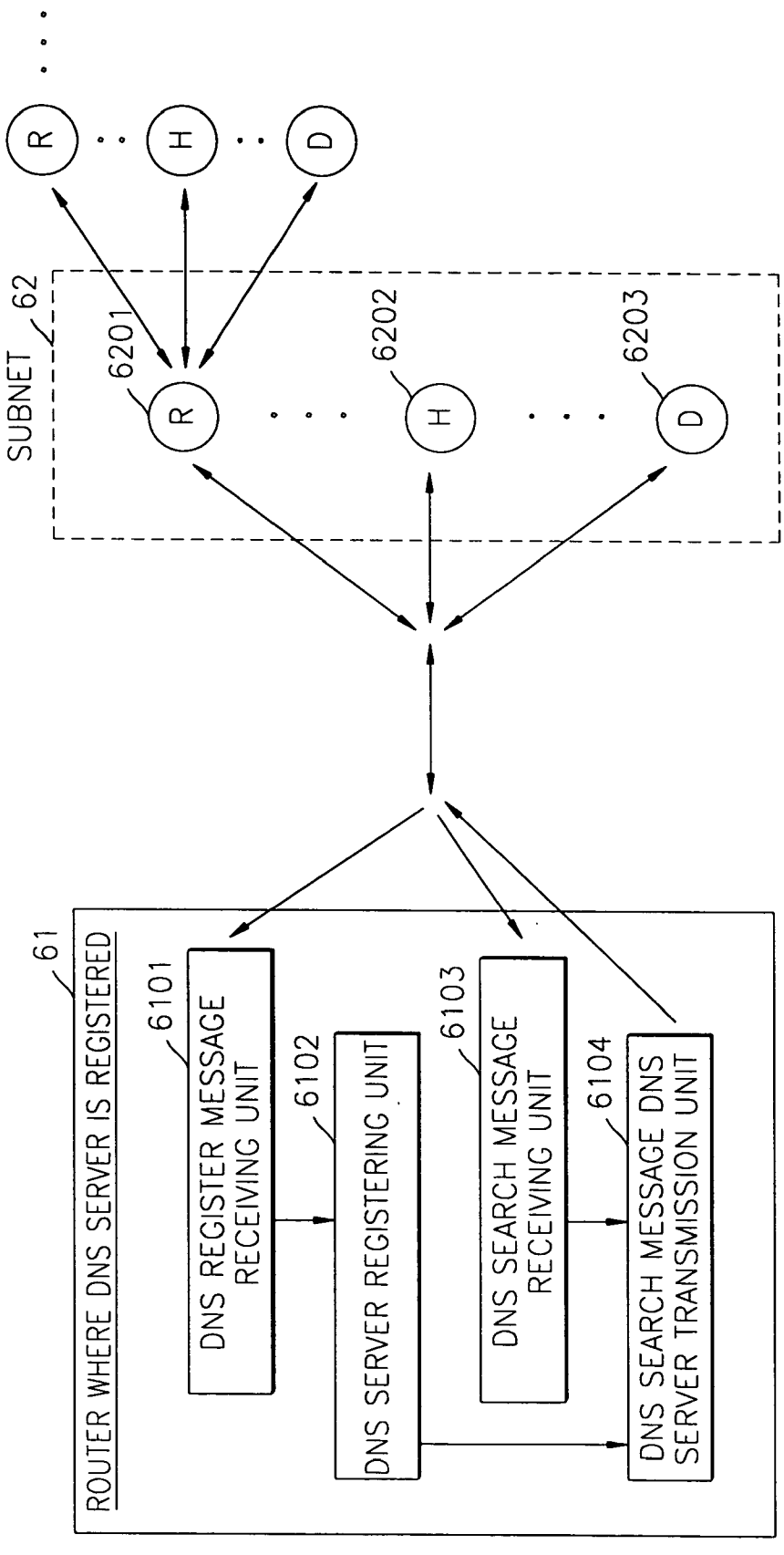

R
H
D
SUBNET
62
6201
6202
6203
61
ROUTER WHERE DNS SERVER IS REGISTERED
6101
DNS REGISTER MESSAGE RECEIVING UNIT
6102
DNS SERVER REGISTERING UNIT
6103
DNS SEARCH MESSAGE RECEIVING UNIT
6104
DNS SEARCH MESSAGE DNS SERVER TRANSMISSION UNIT

FIG. 7

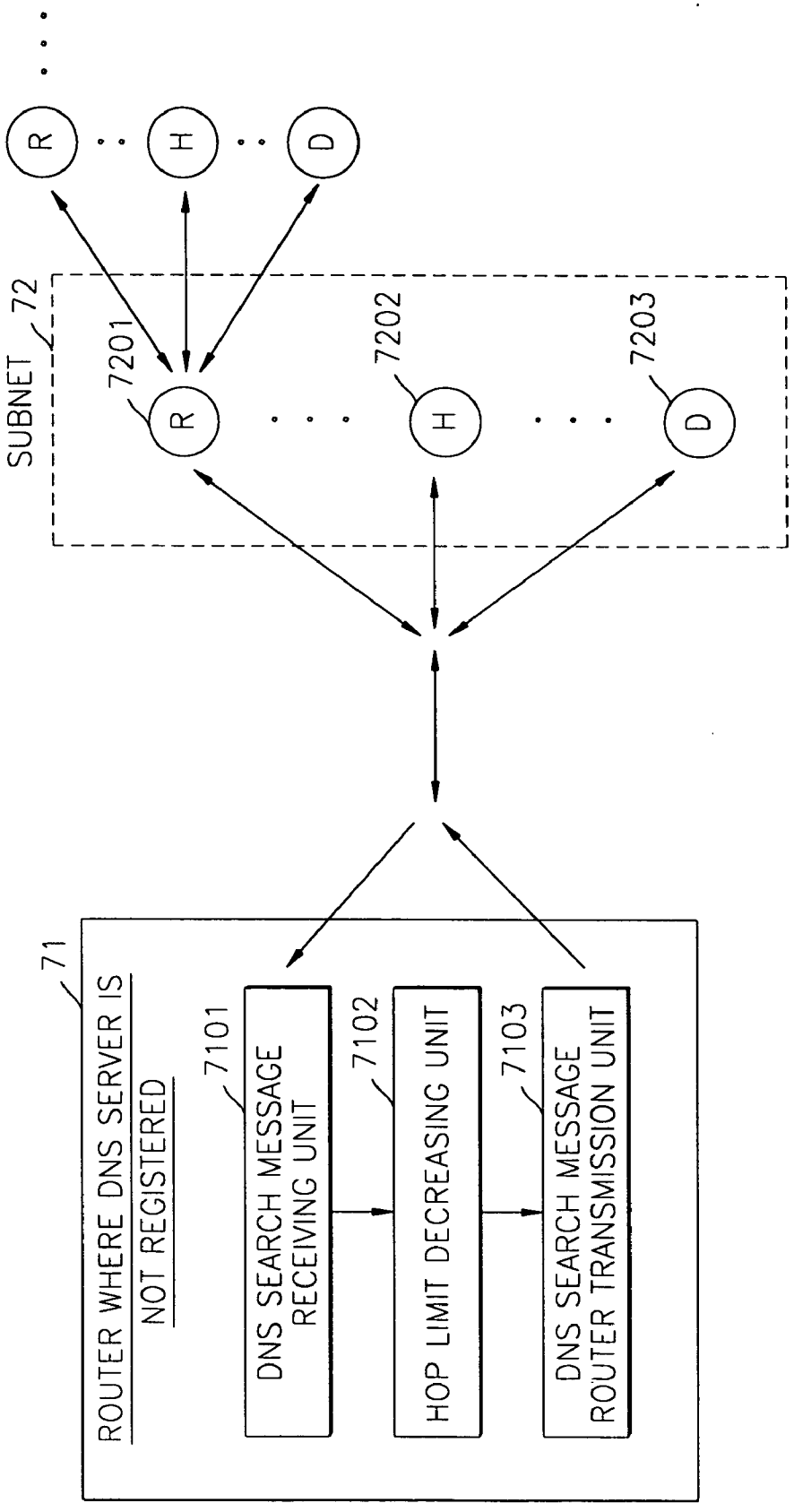

71
ROUTER WHERE DNS SERVER IS NOT REGISTERED
7101
DNS SEARCH MESSAGE RECEIVING UNIT
7102
HOP LIMIT DECREASING UNIT
7103
DNS SEARCH MESSAGE ROUTER TRANSMISSION UNIT
SUBNET 72
7201
7202
7203
R
H
D

FIG. 8

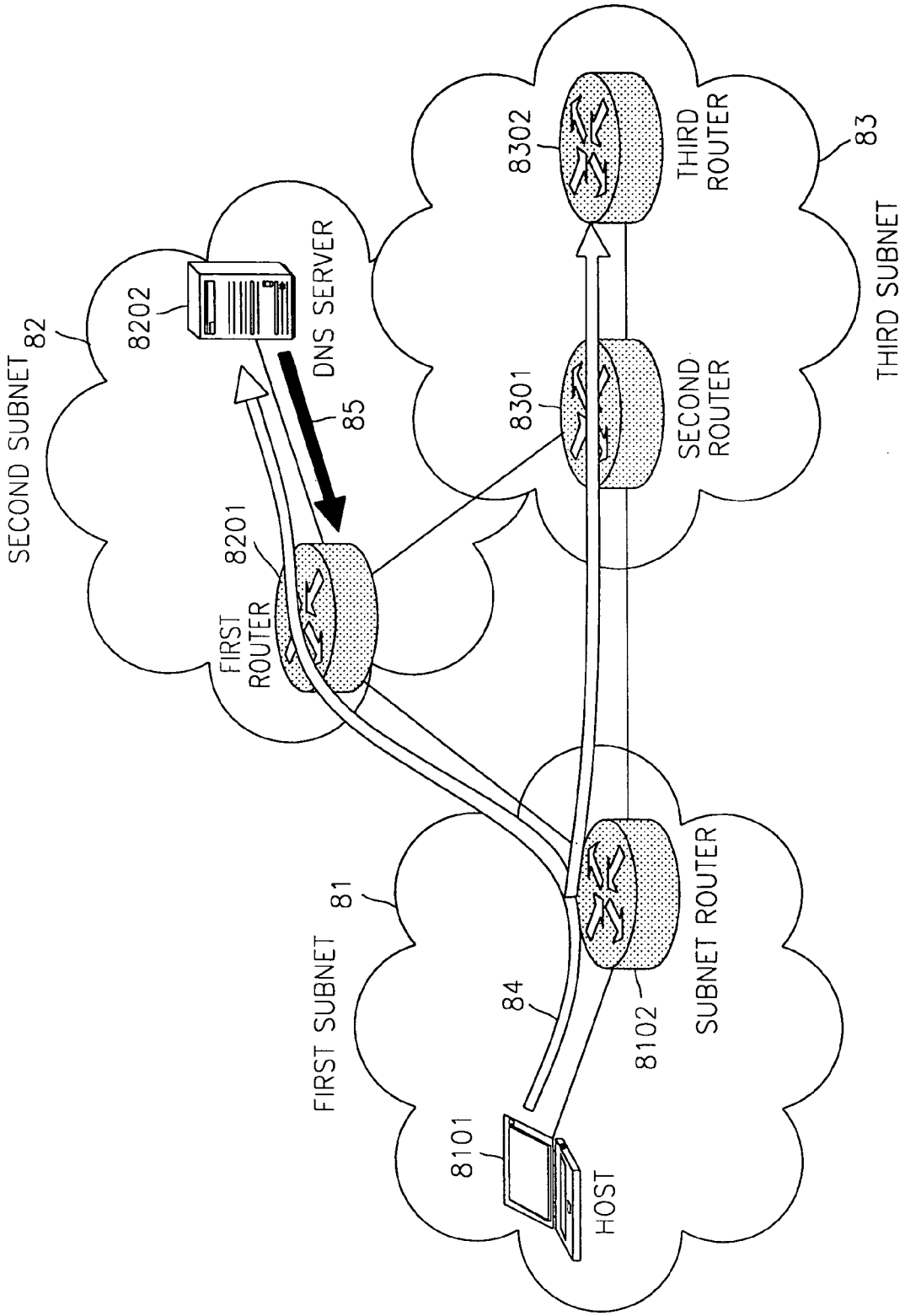

SECOND SUBNET
82
8202
DNS SERVER
85
8201
FIRST ROUTER
8302
THIRD ROUTER
83
THIRD SUBNET
8301
SECOND ROUTER
FIRST SUBNET
81
84
8102
SUBNET ROUTER
8101
HOST

FIG. 9

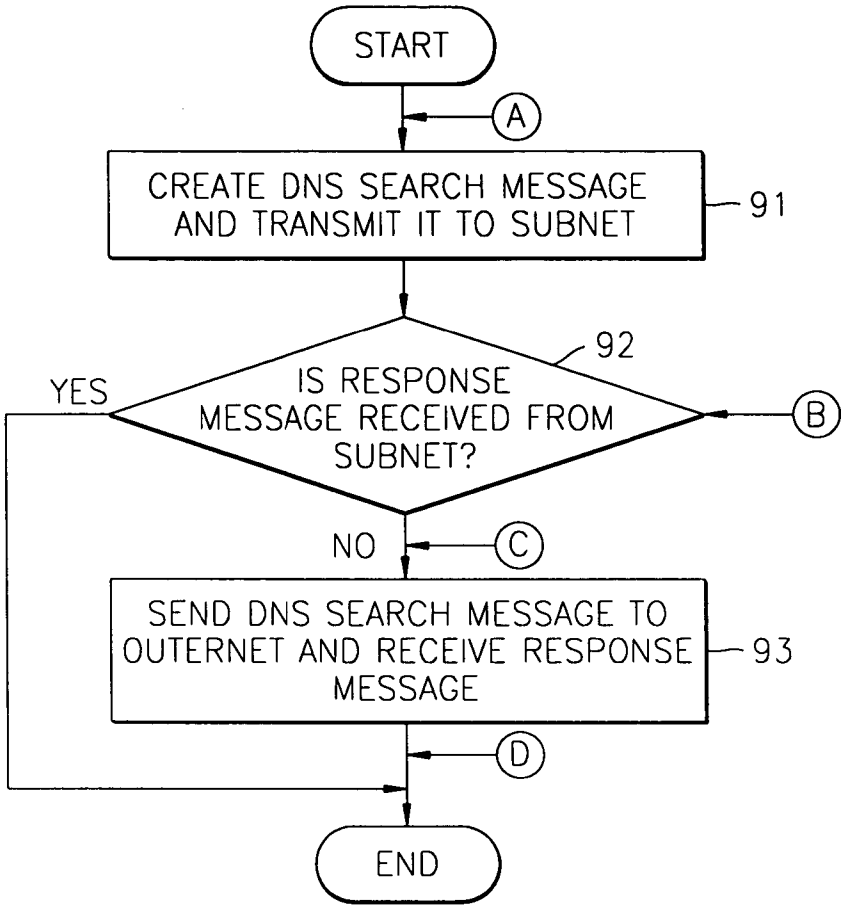

START
A
CREATE DNS SEARCH MESSAGE AND TRANSMIT IT TO SUBNET
91
92
IS RESPONSE MESSAGE RECEIVED FROM SUBNET?
YES
B
NO
C
SEND DNS SEARCH MESSAGE TO OUTERNET AND RECEIVE RESPONSE MESSAGE
93
D
END

FIG. 10

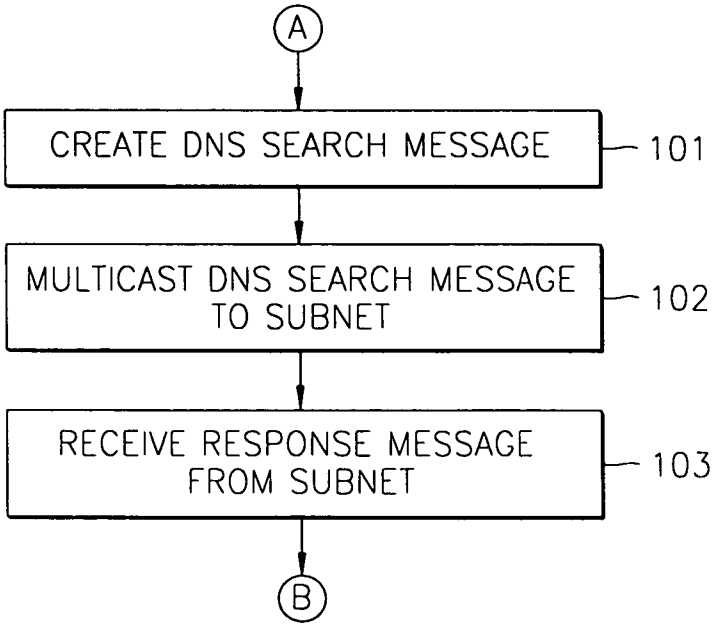

A
CREATE DNS SEARCH MESSAGE
101
MULTICAST DNS SEARCH MESSAGE TO SUBNET
102
RECEIVE RESPONSE MESSAGE FROM SUBNET
103
B

FIG. 11

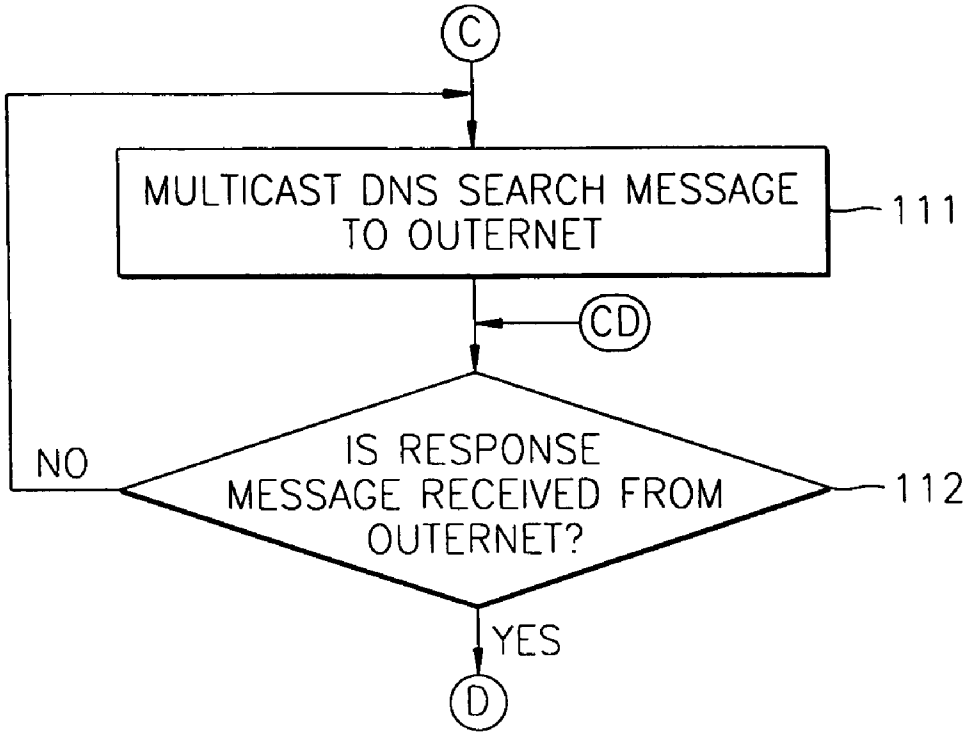

C
MULTICAST DNS SEARCH MESSAGE TO OUTERNET
111
CD
IS RESPONSE MESSAGE RECEIVED FROM OUTERNET?
112
NO
YES
D

FIG. 12

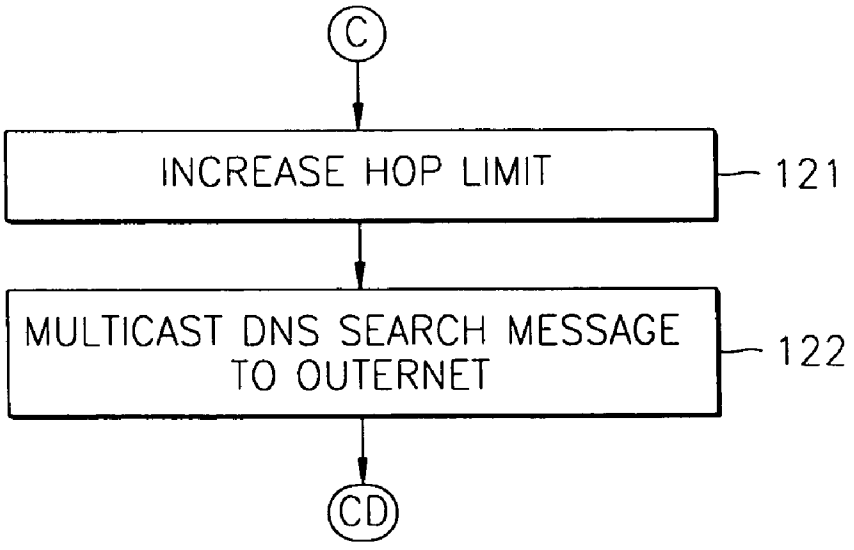

C
INCREASE HOP LIMIT
121
MULTICAST DNS SEARCH MESSAGE TO OUTERNET
122
CD

FIG. 13

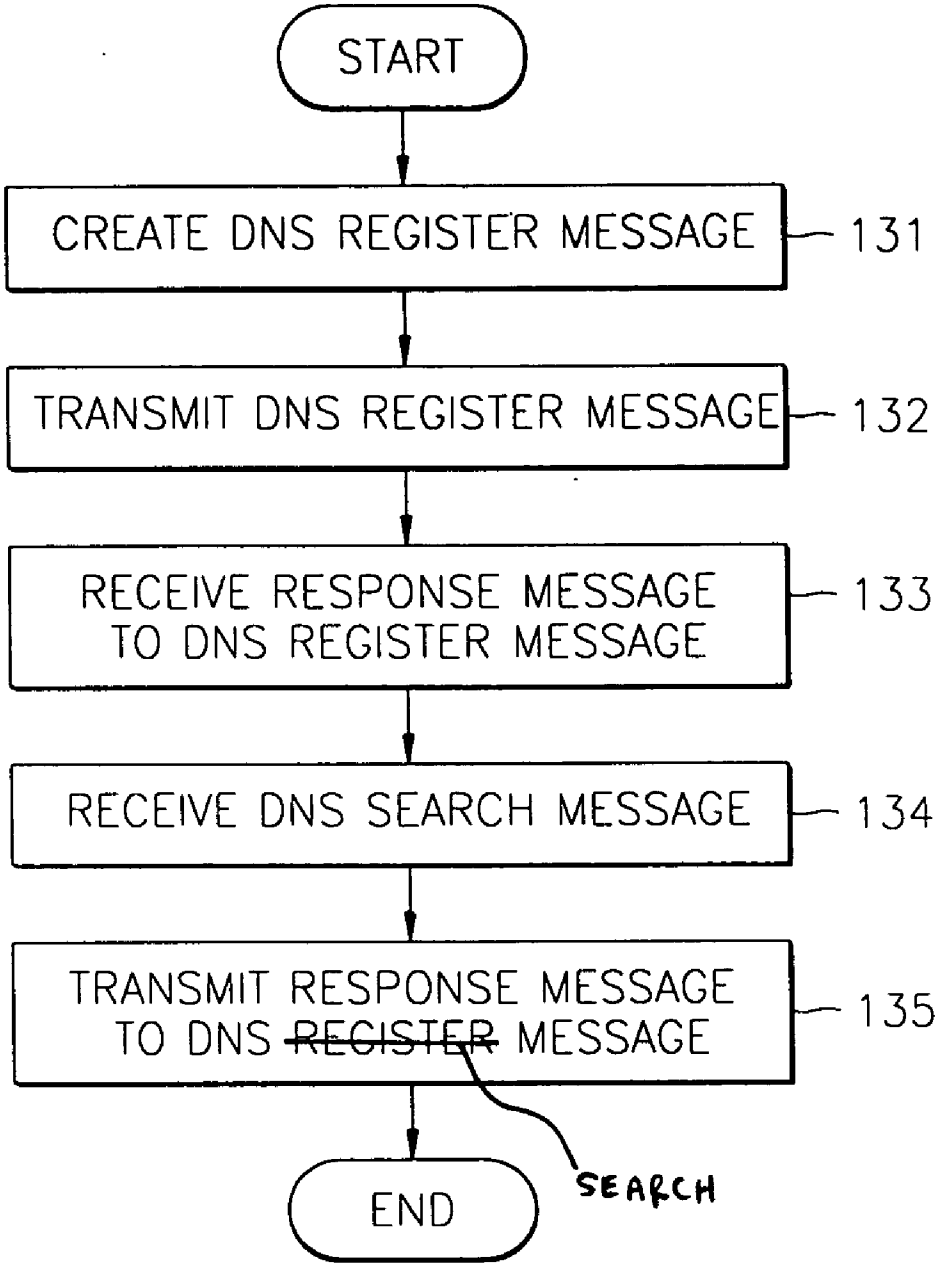

START
CREATE DNS REGISTER MESSAGE
131
TRANSMIT DNS REGISTER MESSAGE
132
RECEIVE RESPONSE MESSAGE TO DNS REGISTER MESSAGE
133
RECEIVE DNS SEARCH MESSAGE
134
TRANSMIT RESPONSE MESSAGE TO DNS ~~REGISTER~~ MESSAGE
135
SEARCH
END

FIG. 14

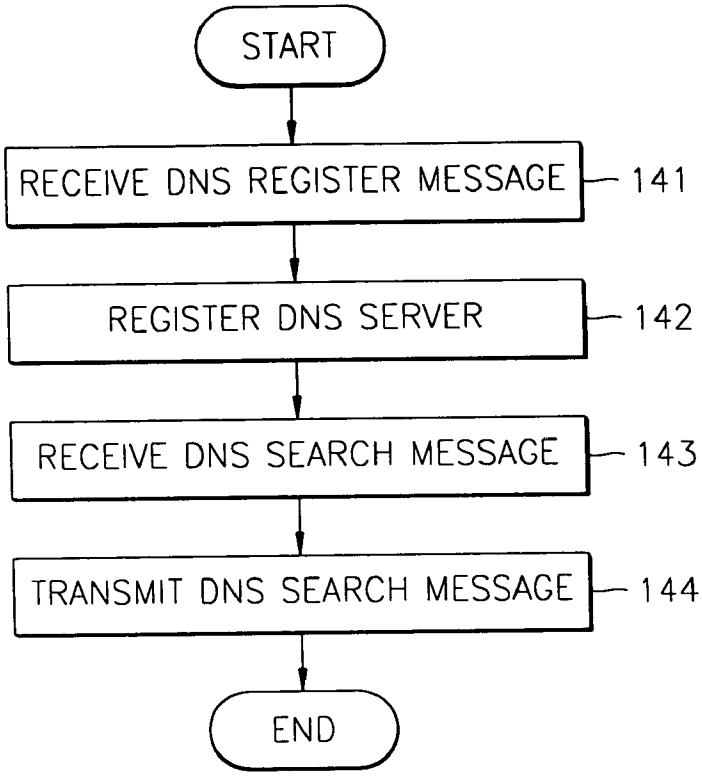

START
RECEIVE DNS REGISTER MESSAGE
141
REGISTER DNS SERVER
142
RECEIVE DNS SEARCH MESSAGE
143
TRANSMIT DNS SEARCH MESSAGE
144
END

FIG. 15

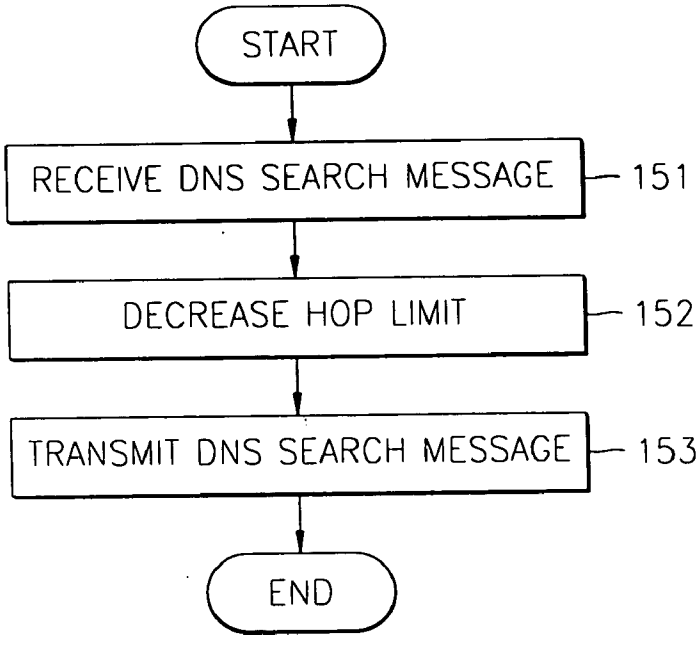

START
RECEIVE DNS SEARCH MESSAGE
151
DECREASE HOP LIMIT
152
TRANSMIT DNS SEARCH MESSAGE
153
END

FIG. 16

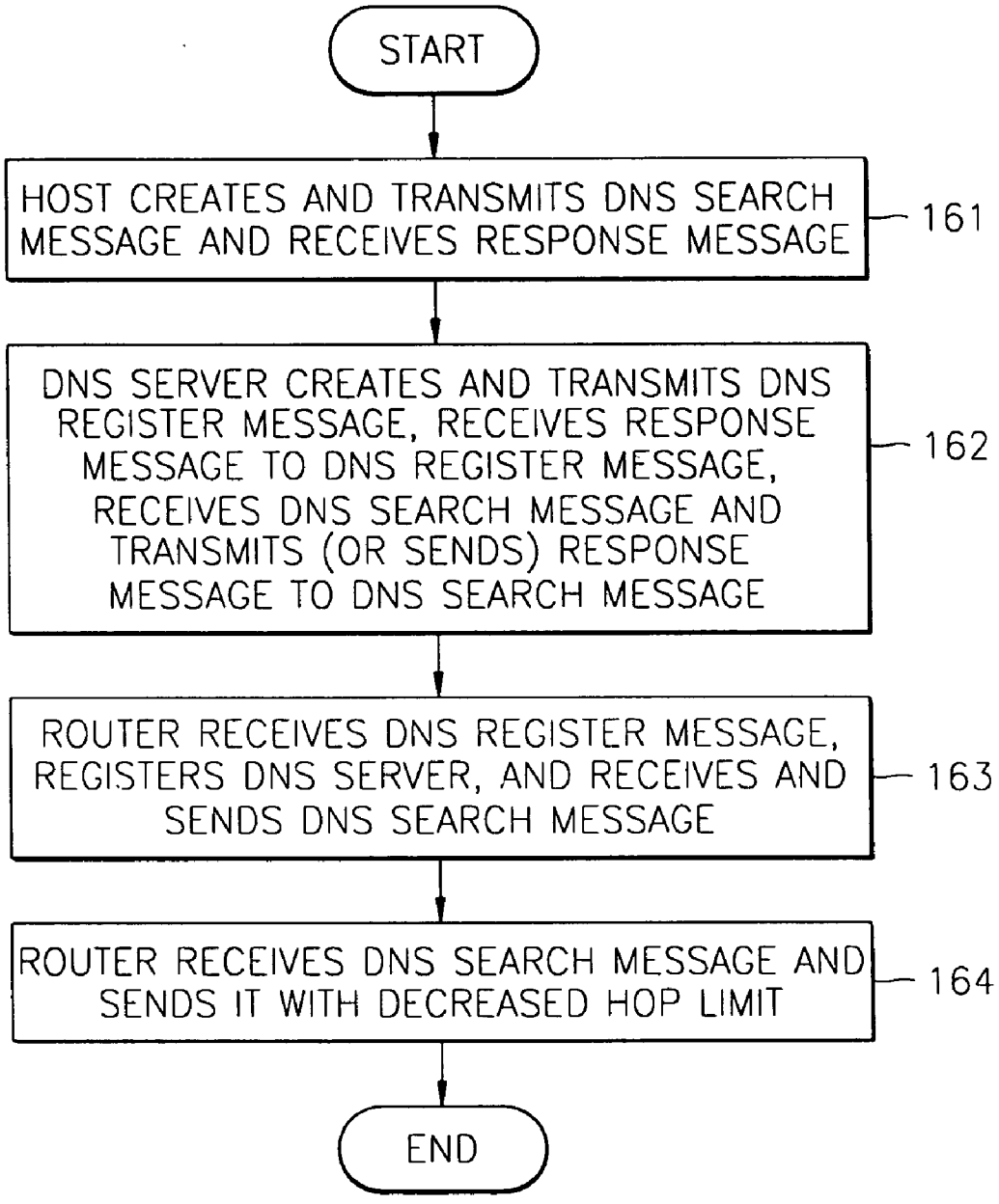

START
HOST CREATES AND TRANSMITS DNS SEARCH MESSAGE AND RECEIVES RESPONSE MESSAGE
161
DNS SERVER CREATES AND TRANSMITS DNS REGISTER MESSAGE, RECEIVES RESPONSE MESSAGE TO DNS REGISTER MESSAGE, RECEIVES DNS SEARCH MESSAGE AND TRANSMITS (OR SENDS) RESPONSE MESSAGE TO DNS SEARCH MESSAGE
162
ROUTER RECEIVES DNS REGISTER MESSAGE, REGISTERS DNS SERVER, AND RECEIVES AND SENDS DNS SEARCH MESSAGE
163
ROUTER RECEIVES DNS SEARCH MESSAGE AND SENDS IT WITH DECREASED HOP LIMIT
164
END

FIG. 17

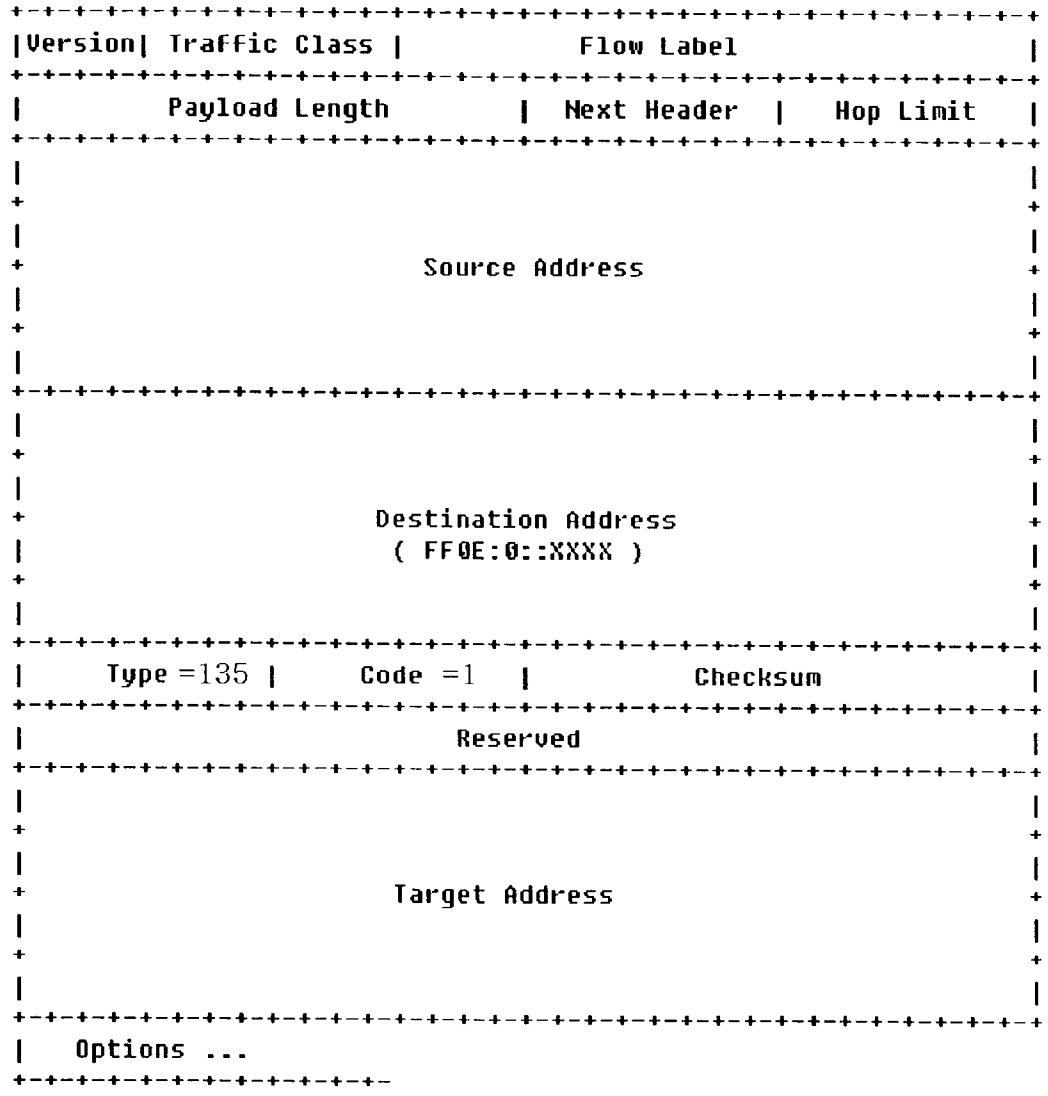
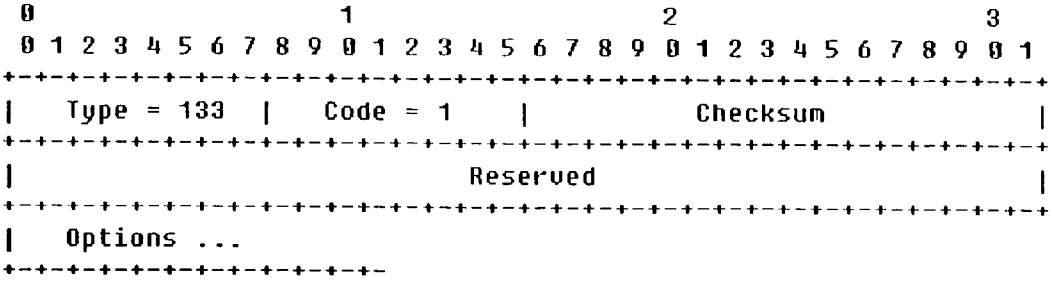

|Version| Traffic Class | Flow Label
| Payload Length | Next Header | Hop Limit
Source Address
Destination Address
(FF0E:0::XXXX)
Type =135 | Code =1 | Checksum
Reserved
Target Address
Options ...

FIG. 18


0 1 2 3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
Type = 133 | Code = 1 | Checksum
Reserved
Options ...

APPARATUS AND METHOD OF SEARCHING FOR DNS SERVER IN OUTERNET

BACKGROUND OF THE INVENTION

[0001] This application claims the priority of Korean Patent Application No. 2002-35140, filed 22 Jun., 2002 in the Korean Intellectual Property Office, which is incorporated herein in its entirety by reference.

[0002] 1. Field of the Invention

[0003] The present invention relates to an apparatus and method of allowing Internet-enabled information terminals to be directly connected to the Internet without setting a user in a subnet network, and more particularly, to an apparatus and method of automatically searching for a Domain Name System (DNS) server in an outernet for a network in which a DNS server is not present.

[0004] 2. Description of the Related Art

[0005] When the address of a server using the Internet Protocol version 6 (IPv6) is obtained using the existing Dynamic Host Configuration Protocol (DHCP) method, a DHCP server sends the address together with information regarding a DNS server. Therefore, the address of the DNS server can be obtained during allocation of an information provider via the DHCP server. The DHCP refers to a protocol that enables central management and allocation of Internet Protocol (IP) addresses of network managers in a network of an organization. According to the Transmission Control Protocol/Internet Protocol (TCP/IP) of the Internet, only a computer having an inherent IP address can connect to the Internet. That is, each computer user belonging to an organization shall be allocated an identification IP address for his/her computer so as to connect to the Internet. Unless the DHCP method is used, an IP address must be manually input to each computer, and if a computer is moved to a different place connected to the network, the computer must be allocated with a new IP address. The DHCP method enables central management and allocation of IP addresses of a network manager, and automatic transmission of a new IP address to a computer moved to a different place connected to the network. The DNS is a system for changing the name of an Internet domain into its identification IP address that is used to detect the location of the Internet domain in the Internet. The name of an Internet domain refers to its Internet address allowing users to easily detect and remember the Internet domain. A digital IP address is required to detect the location of a computer on the Internet. The DNS server holds a database regarding domain names and their corresponding IP addresses and provides them to a computer requiring the database. When an IPv6 address is automatically created using a stateless address autoconfiguration method, a router in the same link periodically reports DNS information, and thus, the address of the DNS server can be obtained from the DNS information.

[0006] However, when an IPv6 address is automatically created using the conventional stateless address autoconfiguration method, it is impossible to automatically obtain the address of a DNS server using the conventional method if a DNS server is not present in a subnet. In other words, during autoconfiguration of the IPv6 address, the address of a DNS server can be easily detected using the conventional method only when the DNS server is present within a subnet.

SUMMARY OF THE INVENTION

[0007] To solve the above and other problems, the present invention provides an apparatus and method of automatically detecting the address of a (DNS) server in an outernet using the IPv6 global scope multicast address and the IPv6 subnet anycast address, when the DNS server is not present in a subnet.

[0008] According to one aspect of the present invention, there is provided an apparatus for searching for a DNS server in an outernet, the apparatus including a first outernet DNS searching unit included in a host. The first searching unit creating a DNS search message and transmitting it to a first subnet so as to receive a response message to the DNS search message, and the first searching unit transmitting the DNS search message to an outernet when the response message is not transmitted. The host belongs to the first subnet and does not belong to the outernet. The apparatus further includes a second outernet DNS searching unit included in a DNS server. The second searching unit creating a DNS register message, transmitting it to a second subnet to receive a response message to the DNS register message from a first router belonging to the second subnet, receiving a DNS search message related to the DNS server from the first router, and sending a response message to the DNS search message to the first router. The apparatus further includes a third outernet DNS searching unit included in a router where a DNS server is registered. The third searching unit receiving a DNS register message from the DNS server and registering the DNS server with the router, receiving a DNS search message from the second subnet, and transmitting the DNS search message to the registered DNS server. The apparatus further includes a fourth outernet DNS searching unit included in a router where a DNS server is not registered. The fourth searching unit receiving a DNS search message from a third subnet, transmitting the DNS search message with a hop limit to a third router belonging to the third subnet, and decreasing the hop limit by a predetermined value. A second router also belongs to the third subnet.

[0009] According to another aspect of the present invention, there is provided a method of searching for a DNS server on an outernet, the method including creating a DNS search message and transmitting it to a first subnet to which a host belongs so as to receive a response message to the DNS search message, and transmitting the DNS search message to an outernet to which the host does not belong so as to receive the response message; creating a DNS register message, transmitting it to a second subnet to which a DNS server belongs, receiving a response message to the DNS register message from a first router belonging to the second subnet, receiving a DNS search message related to the DNS server from the first router, and transmitting a response message to the DNS search message to the first router; receiving the DNS register message from the DNS server to register the DNS server to the first router, receiving a DNS search message from the second subnet, and transmitting the DNS search message to the registered DNS server; and receiving a DNS search message from a third subnet to which a second router belongs, transmitting the DNS search message with a hop limit to a third router, and decreasing the hop limit by a predetermined value.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] The above and other aspects and advantages of the present invention will become more apparent by describing in detail illustrative, non-limiting embodiments thereof with reference to the attached drawings in which:

[0011] **FIG. 1** is a diagram illustrating the structure of an outernet domain name system (DNS) searching apparatus of a host according to the present invention;

[0012] **FIG. 2** is a diagram illustrating the structure of a subnet DNS searching unit of the apparatus of **FIG. 1**;

[0013] **FIG. 3** is a diagram illustrating the structure of an outernet DNS searching unit of the apparatus of **FIG. 1**;

[0014] **FIG. 4** is a diagram illustrating the structure of a DNS search message transmission unit of the outernet DNS searching unit of **FIG. 3**;

[0015] **FIG. 5** is a diagram illustrating the structure of an outernet DNS searching apparatus of a DNS server according to the present invention;

[0016] **FIG. 6** is a diagram illustrating the structure of an outernet DNS searching apparatus of a router where a DNS server is registered;

[0017] **FIG. 7** is a diagram illustrating the structure of an outernet DNS searching apparatus of a router where a DNS server is not registered;

[0018] **FIG. 8** is a diagram illustrating the overall structure of an apparatus for searching for a DNS server in an outernet;

[0019] **FIG. 9** is a flow chart illustrating a method performed by a host, for searching for a DNS server in an outernet, according to the present invention;

[0020] **FIG. 10** is a flow chart illustrating a method of searching for a DNS server in a subnet, which is a part of the method of **FIG. 9**, according to the present invention;

[0021] **FIG. 11** is a flow chart illustrating a method of searching for a DNS server in an outernet, which is a part of the method of **FIG. 9**, according to the present invention;

[0022] **FIG. 12** is a flow chart illustrating a method of transmitting a DNS search message, which is included in the method of **FIG. 11**;

[0023] **FIG. 13** is a flow chart illustrating a method performed by a DNS server, for searching for the DNS server in an outernet, according to the present invention;

[0024] **FIG. 14** is a flow chart illustrating a method of searching for a DNS server in an outernet, the method performed by a router where a DNS server is registered, according to the present invention;

[0025] **FIG. 15** is a flow chart illustrating a method of searching for a DNS server in an outernet, the method performed by a router where a DNS server is not registered, according to the present invention;

[0026] **FIG. 16** is an overall flow chart illustrating a method of searching for a DNS server in an outernet;

[0027] **FIG. 17** is a view of one example of a DNS search message; and

[0028] **FIG. 18** is a view of another example of a DNS search message.

DETAILED DESCRIPTION OF THE INVENTION

[0029] **FIG. 1** is a diagram illustrating the structure of an outernet domain name system (DNS) searching apparatus of a host **11**, according to the present invention. The apparatus includes a subnet DNS searching unit **1101** and an outernet DNS searching unit **1102**.

[0030] The subnet DNS searching unit **1101** creates a DNS search message and transmits it to a subnet **12**, to which the host **11** belongs, and further receives a response message to the DNS search message from the subnet **12**. The subnet **12** includes at least one of routers **1201** and **1202** and at least one DNS server **1203** connected directly to the host **11**.

[0031] Alternatively, the subnet **12** may be composed of only one router or one DNS server. When the subnet **12** consists of only one router, the subnet DNS searching unit **1101** can obtain information regarding the address of a DNS server (not shown) if the DNS server is registered with the router, i.e., the information is stored in a DNS server address database of the router. In this case, the subnet DNS searching unit **1101** creates a DNS search message and sends it to the subnet **12**, to which the host **11** belongs, to receive a response message to the DNS search message. The response message contains the information regarding the address of the DNS server that is registered with the router. If the subnet **12** consists of only one DNS server **1203**, it is possible to obtain the information directly from the DNS server **1203**. If the subnet **12** consists of several routers and a DNS server is registered with some of the routers, the host **11** obtains the information regarding the address of the DNS server from the closest router. If the subnet **12** is composed of several DNS servers, the host **11** obtains the information directly from the closest DNS server. However, when the subnet **12** is composed of several routers but a DNS server is not registered with any of the routers, the host **11** cannot receive a response message to a DNS search message even if the subnet DNS searching unit **1101** creates the DNS search message and transmits it to the subnet **12** to which the host **11** belongs.

[0032] When the subnet DNS searching unit **1101** fails to receive any response message to the DNS search message, the outernet DNS searching unit **1102** transmits the DNS search message to an outernet **13**, to which the host **11** does not belong, to receive a response message to the DNS search message. The outernet **13** includes at least one router **1301**, **1302**, or **1303** or at least one DNS server **1304** that is connected indirectly to the host **11**. The indirect connection means that the connection of said at least one router **1301**, **1302**, or **1303** or said at least one DNS server **1304** to the host **11** requires the router **1201** or **1202** or the DNS server **1203** to be included in the subnet **12**.

[0033] Alternatively, the outernet **13** may be formed of only one router or one DNS server. Although the outernet **13** consists of only one router, if a DNS server is registered with the router, i.e., information regarding the address of the DNS server is stored in a DNS server address database of the router, the DNS search message is transmitted to the outernet **13**, to which the host **11** does not belong, so as to receive a response message thereof. In this manner, the host **11** obtains

the information regarding the DNS server address, contained in the response message. When the outernet **13** consists of only one DNS server **1304**, the host **11** obtains the information regarding the address of the DNS server **1304** directly from the DNS server **1304**. If the outernet **13** consists of several routers and a DNS server is registered with some of the routers, the host **11** obtains the information from the closest router. If the outernet **13** is composed of several DNS servers, the host **11** obtains the information directly from the closest DNS server. However, when the outernet **13** is composed of several routers but a DNS server is not registered with any of the routers, the host **11** cannot receive a response message to the DNS search message even if the outernet DNS searching unit **1102** creates the DNS search message and transmits it to the outernet **13** to which the host **11** does not belong.

[**0034**] However, since an outernet is often established in a current network environment, the presence of a DNS server is guaranteed. Therefore, information regarding the address of a DNS server is certain to be obtained if the range of a hop limit is set to be sufficiently large.

[**0035**] **FIG. 2** is a diagram illustrating the structure of a subnet DNS searching unit of an outernet DNS searching apparatus of a host, according to the present invention. The subnet DNS searching unit includes a DNS search message creating unit **21**, a DNS search message transmission unit **22**, and a DNS search response message receiving unit **23**.

[**0036**] The DNS search message creating unit **21** automatically creates the address of a transmitter and the DNS search message. In an IPv6environment, an IP address may not only be allocated from a DHCP server in an IPv4 environment, but also, a host may automatically create its IP address by itself. The former method and the latter method are called "stateful address autoconfiguration" and "stateless address autoconfiguration", respectively, and are defined in the Request for Comments (RFC) 2462. The DHCP refers to a protocol that enables central management and allocation of IP addresses of network managers. According to the present invention, the address of a transmitter is automatically created by the DNS search message creating unit **21** using the stateless address autoconfiguration method under the IPv6 environment. In the case of the Internet Control Message Protocol version 6 (ICMPv6), an ICMP suitable for the IPv6 environment, the DNS search message is created by inputting the address of a transmitter to the field of a source address and the address of a receiving part, FF0E:0::XXXX, to the field of a destination field. In the address of a receiving part FF0E:0::XXXX, FF denotes a multicast address, 0 between FF and E denotes a permanent address, and 0 between the marks :: denotes a global address (refer to RFC 2375 for more details). The DNS search message transmission unit **22** multicasts the DNS search message to each node of the subnet **24**. As previously mentioned, each node of the subnet **24** may be a router or a DNS server. The "multicast" refers to a manner of data transmission in which at least one transmitter (a host according to the present invention) transmits data to at least one particular receiving part (each node of a subnet according to the present invention).

[**0037**] Inputting the address of a global scope multicast address, FF0E:0::XXXX, to the field of a destination address results in the multicast transmission of data.

[**0038**] The DNS search response message receiving unit **23** receives a response message to the DNS search message from any node of the subnet **24**. As mentioned above, each node of the subnet **24** may be a router or DNS server. The response message to the DNS search message contains information regarding the address of a DNS server. Once the host obtains the information, i.e., the IP address, the host connects to the DNS server and is given domain name services.

[**0039**] **FIG. 3** is a diagram illustrating the structure of an outernet DNS searching unit of an outernet DSN searching apparatus of a host, according to the present invention. The outernet DNS searching unit includes a DSN search message transmission unit **31** and a DNS search response message receiving unit **32**.

[**0040**] If the subnet DNS searching unit of **FIG. 2** does not receive a response message, the DNS search message transmission unit **31** multicasts a DNS search message to each node of an outernet **33** until it receives a response message to its DNS search message. Like in the subnet **24**, each node of the outernet **33** may be a router or a DNS server. Because a DNS server is present within the outernet **33**, the DNS search message is repeatedly multicast to each node of the outernet **33** while gradually broadening a search region until the DNS server is detected, i.e., until a response message to the DNS search message is received.

[**0041**] The DNS search response message receiving unit **32** receives a response message from any node of the outernet **33**. Like the subnet **24**, the response message contains information regarding the address of a DNS server.

[**0042**] **FIG. 4** is a diagram illustrating the structure of the DNS search message transmission unit of the outernet DNS searching unit of **FIG. 3**. Referring to **FIG. 4**, the DNS message transmission unit includes a hop limit setting unit **41** and a DNS search message repetition transmission unit **42**.

[**0043**] The hop limit setting unit **41** repeatedly increases a currently set hop limit by a predetermined value whenever the outernet DNS searching fails to receive a response message to a DNS search message, in the event that the subnet DNS searching unit **1101** of **FIG. 2** does not receive the response message. That is, the hop limit setting unit **41** resends the DNS search message while increasing the hop limit when a DSN server does not respond to the DNS search message transmitted from a host. As previously mentioned with reference to **FIG. 3**, the DNS search message is repeatedly multicast to each node of the outernet **33** while broadening a search area, until a DNS server is detected, i.e., the response message to the DNS search message is received. For repetitive multicast transmission of the DNS search message, a data packet of the DNS search message must be transmitted while increasing the hop limit whenever the DNS search message is transmitted. The hop limit corresponds to a time-to-live (TTL) value of the IPv4 environment. For example, when the hop limit is set to 3 and the DNS search message is multicast to the routers **1201** and **1202** of **FIG. 1**, the DNS search message is multicast to the outer routers **1301**, **1302**, **1303**, and **1304** while reducing the hop limit by 1. When the hop limit is reduced to 0, multicast transmission of the DNS search message to adjacent routers is stopped. Two reasons why the hop limit is initially set to a small value and gradually increased during the multicast transmission are to prevent the waste of network bandwidth and to detect the closest DNS server. If the hop limit is

initially set to a large value, the hop limit does not reach 0 and transmission of the DNS search message is not stopped until the DNS search message is passed through a lot of routers, thereby wasting time and network bandwidth.

[0044] The DNS search message repetition transmission unit **42** repeatedly multicasts the DNS search message to each node of the outernet **43** based on the set hop limit until the DNS search response message receiving unit receives a response message to the DNS search message. That is, until the host obtains information of the address of a certain DNS server, i.e., IP address, the DNS search message repetition transmission unit **42** repeatedly multicasts the DNS search message to each node of the outernet **43** based on the set hop limit. For example, if the set hop limit is 3, a DNS server is searched for while transmitting the DNS search message to pass through three routers with respect to one of several multicast transmission paths.

[0045] **FIG. 5** is a diagram of an outernet DNS searching apparatus included in a DNS server **51**, according to the present invention. Referring to **FIG. 5**, the apparatus includes a DNS register message creating unit **5101**, a DNS register message transmission unit **5102**, a DNS register response message receiving unit **5103**, a DNS search message receiving unit **5104**, and a DNS search response message transmission unit **5105**.

[0046] The DNS register message creating unit **5101** creates a DNS register message with the address of a certain DNS server as that of a transmitter. Like the DNS search message creating unit **21** of **FIG. 2**, the DNS register message creating unit **5101** automatically creates the address of a transmitter using the stateless address autoconfiguration method under the IPv6 environment. In the ICMPv6, an ICMP under the IPv6 environment, the address of a transmitter is input to a source address field and an anycast address is input to a destination address field to create the DNS register message. The DNS register message transmission unit **5102** transmits the DNS register message to a subnet **52** to which the DNS server **51** belongs. The subnet **52** includes a host **5203** or at least one router directly connected to the DNS server **51**, and the host **5203** or each router becomes a node of the subnet **52**. The DNS register message transmission unit **5102** anycasts the DNS search message to each node of the subnet **52**. Here, "anycast" refers to a manner of data transmission in which a single transmitter (the DNS server **51** according to the present invention) transmits data to some of the closest receiving parts within the subnet **52** (routers according to the present invention). Therefore, according to IPv6, it is possible to detect the closest receiving part and transmit a data packet to the receiving part, which is similar to a unicast transmission method. As described above, input of an anycast address in the destination address field results in an anycast transmission of data. The DNS register response message receiving unit **5103** receives a response message in response to the DNS register message from one of routers **5201** and **5202** belonging to the subnet **52**. The one of the routers **5201** and **5202** refers to the first router that responds to the DNS register message, i.e., the closest router. Upon receiving the response message, one-to-one communication is made between the DNS server **51** and the router nearest to the DNS server **51** as in the unicast method. The response message to the DNS register message contains information that the DNS server **51** is normally registered with the nearest router, i.e., information that the IP address of the DNS server **51** is completely stored in a database of the router. The DNS search message receiving unit **5104** receives a DNS search message from the nearest router. The nearest router refers to one where the DNS server **51** is registered, and thus, the IP address of the DNS server **51** can be detected via the router to transmit the DNS search message to the DNS server **51**. The DNS search response message transmission unit **5105** transmits the response message to the DNS search message to the router. The response message contains information regarding the address of the DNS server **51**, i.e., the IP address of the DNS server **51**.

[0047] **FIG. 6** is a diagram of an outernet DNS searching apparatus included in a router **61** where a DNS server is registered, according to the present invention. Referring to **FIG. 6**, the apparatus includes a DNS register message receiving unit **6101**, a DNS server registering unit **6102**, a DNS search message receiving unit **6103**, and a DNS search message DNS server transmission unit **6104**.

[0048] The DNS register message receiving unit **6101** receives a DNS register message from a subnet **62** to which a certain router belongs. The subnet **62** includes a host **6202**, at least one router **6201**, or at least one DNS server **6203**, which is connected directly to the router **61**. The DNS register message is transmitted from the DNS server **6203** using the anycast method, and thus, said certain router is the router nearest to the DNS sever **6203**. The DNS server registering unit **6102** registers the DNS server **6203** related to the DNS register message with the router. In general, registration of the DNS server **6203** is performed by storing its IP address in an IP address database of the router **61**. The DNS search message receiving unit **6103** receives a DNS search message from the subnet **62**. If the host **6202** is included in the subnet **62**, the DNS search message is transmitted directly from the host **6202** to the DNS search message receiving unit **6103**. If the host **6202** is not included in the subnet **62**, the DNS search message is passed through several routers based on a set hop limit and sent to the DNS search message receiving unit **6103** from a router nearest to the DNS server **6203**. The DNS search message DNS server transmission unit **6104** transmits the DNS search message to the registered DNS server **6203**. For one-to-one connection of the host **6202** and the DNS server **6203** to convert a domain name into an IP address, the DNS search message DNS server transmission unit **6104** transmits the DNS search message to the registered DNS server **6203**.

[0049] **FIG. 7** is a block diagram of an outernet DNS searching apparatus included in a router **71** where a DNS server is not registered, according to the present invention. The apparatus includes a DNS search message receiving unit **7101**, a hop limit decreasing unit **7102**, and a DNS search message router transmission unit **7103**.

[0050] The DNS search message receiving unit **7101** receives a DNS search message from a subnet **72** to which a certain router belongs. The subnet **72** includes a host **7202**, at least one router **7201**, or at least one DNS server **7203** that is connected directly to the router **71**. If the subnet **72** includes the host **7202**, the DNS search message is transmitted directly from the host **7202**, and otherwise, the DNS search message is passed through several routers based on a hop limit and transmitted to the certain router. The hop limit decreasing unit **7102** decreases the hop limit for the DNS

search message by a predetermined value. In general, the predetermined value is set to 1. For instance, if the hop limit is set to 3, it decreases by 1 whenever the DNS search message passes through a router, until it finally becomes 0. When the hop limit is 0, the DNS search message is not transmitted to any further routers.

[0051] The DNS search message router transmission unit **7103** transmits the DNS search message to another router belonging to the subnet **72** while reducing the hop limit. In general, a subnet includes nodes connected directly to a certain router. Subnets may form a new subnet at a border region between subnets, and in this case, the overall net can be formed of a plurality of subnets since they are connected to one another. Therefore, if the range of a hop limit is set to be sufficiently broadly, all nodes of the overall net can be searched.

[0052] **FIG. 8** is a diagram illustrating an apparatus for searching for a DNS server in an outernet, the apparatus to which an outernet DNS searching apparatus of a host **8101**, an outernet DNS searching apparatus of a DNS server **8202**, an outernet DNS searching apparatus of a first router **8201** where a DNS server is registered, and an outernet DNS searching apparatus of a second router **8301** where no DNS server is registered, are connected.

[0053] The outernet DNS searching apparatus of the host **8101** creates a DNS search message and transmits it to a first subnet **81**, to which the host belongs, to receive a response message to the DNS search message. If the first subnet **81** does not send a response message, the outernet DNS searching apparatus of the host **8101** creates a DNS search message and transmits it to a second subnet **82** and a third subnet **83**, to which the host does not belong, to receive a response message to the DNS search message. The outernet DNS searching apparatus of the DNS server **8202** creates a DNS search message and transmits it to the second subnet **82**, to which a certain DNS server belongs, so as to receive a response message to the DNS search message from the first router **8201** belonging to the second subnet **82**. Also, the outernet DNS searching unit of the DNS server **8202** receives the DNS search message related to the DNS server **8202** from the first router **8201** and transmits a response message to the DNS search message to the first router **8201**. The outernet DNS searching apparatus of the first router **8201** where the DNS server is registered, receives the DNS register message from the DNS server **8202** and registers the DNS server **8202** with the first router **8201**. Also, the outernet DNS searching apparatus of the first router **8201** receives a DNS search message from the second subnet **82** and transmits it to the registered DNS server **8202**. The outernet DNS searching apparatus of the second router **8301** where a DNS server is not registered, receives a DNS search message from a third subnet **83** to which a second router **8301** belongs, and transmits it to the third router **8302**, which also belongs to the third subnet **83**, while decreasing a hop limit by a predetermined value. Before the DNS search message is sent to the third router **8302**, the DNS search message has already been sent to the second router **8301** from the subnet router **8102** belonging to the first subnet **81**, and therefore, the hop limit decreases by 2 when the DNS search message is transmitted to the third router **8302**. The subnet router **8102** belonging to the first subnet **81** and the second router **8301** belonging to the third subnet **83** are overlapped with each other to form a new subnet. In **FIG. 8**, the subnets **81** to **83** are set centering on the host **8101**, but this is not a hard restriction. That is, according to the present invention, nodes connected directly to one another may function as subnets.

[0054] **FIG. 9** is a flow chart illustrating a method of searching for a DNS server of a host in an outernet, according to the present invention. Referring to **FIG. 9**, first, a DNS search message is created and transmitted to a subnet belonging to a certain host to receive a response message to the DNS search message, in step **91**. Next, it is checked if the response message is received from the subnet in step **92**. If it is determined in step **92** that the response message is not received from the subnet, the DNS search message is sent to an outernet to which the host does not belong and the response message to the sent DNS search message is received from the outernet, in step **93**. If it is determined in step **92** that the response message is received from the subnet, it means information regarding the address of a desired DNS server has been obtained. Therefore, the method of **FIG. 9** is terminated. The subnet includes at least one router or at least one DNS server connected directly to the host.

[0055] **FIG. 10** is a flow chart illustrating a method of searching for a DNS server of a host in a subnet, which is a part of the method of **FIG. 9**, according to the present invention. Referring to **FIG. 10**, first, the address of a transmitter is automatically created to create a DNS search message in step **101**. Next, the DNS search message is transmitted to each node of the subnet, using a multicast method, in step **102**. After step **102**, a response message to the DNS search message is received from any node of the subnet in step **103**.

[0056] **FIG. 11** is a flow chart illustrating a method of searching for a DNS server of a host in an outernet, which is a part of the method of **FIG. 9**, according to the present invention. First, when a response message to the DNS search message is not provided by the subnet, the DNS search message is repeatedly multicast transmitted to each node of the outernet until a response message to the DNS search message is transmitted, in step **111**. After step **111**, it is checked if response messages are sent from any node of the outernet in step **112**. If it is determined in step **112** that a response message is not sent from any node of the outernet, the operation returns back to step **111** and the DNS search message is multicast transmitted to each node of the outernet in step **111**. This is repeated until a response message to the DNS search message is created. Here, the outernet includes at least one router or at least one DNS server connected indirectly to the host.

[0057] **FIG. 12** is a flow chart illustrating an operation for transmitting a DNS search message, which is included in the operation of **FIG. 11**. Referring to **FIG. 12**, first, a currently set hop limit is increased by a predetermined value whenever a response message to a DNS search message is not made, in step **121**. After step **121**, the DNS search message is repeatedly multicast transmitted to each node of an outernet, based on the set hop limit, until a response message is transmitted, in step **122**.

[0058] **FIG. 13** is a flow chart illustrating a method of searching for a DNS server in an outernet, the method performed by an outernet DNS searching apparatus included in a DNS server, according to the present invention. First, a

DNS register message is created with the address of a DNS server as the address of a transmitter in step **131**. Next, the DNS register message is transmitted to a subnet to which the DNS server belongs in step **132**. In this case, the subnet includes a host or at least one router connected directly to the DNS server, and an anycast transmission is used to transmit the DNS search message to each node of the subnet. After step **132**, a response message to the DNS register message is received from a router belonging to the subnet in step **133**. In this case, the router becomes a router where the DNS server is registered. After step **133**, a DNS search message is transmitted to the DNS server from the router in step **134**, which is possible since an IP address of the DNS server is stored in the router. After step **134**, the DNS server sends a response message to the DNS search message to the router in step **135**.

[**0059**] **FIG. 14** is a flow chart illustrating a method of searching for a DNS server in an outernet, the method performed by a router where the DNS server is registered, according to the preset invention. Referring to **FIG. 14**, first, a DNS register message is received from a subnet to which a router belongs in step **141**. The subnet includes a host, at least one router, or at least one DNS server connected directly to the router. After step **141**, a DNS server, which transmitted the DNS register message to the subnet, is registered with the router in step **142**. As mentioned with reference to **FIG. 13**, the DNS server is the transmitter of the DNS register message. After step **142**, a DNS search message is transmitted from the subnet in step **143**, and the router, where the DNS server has been registered, transmits the DNS search message to the registered DNS server, in step **144**.

[**0060**] **FIG. 15** is a flow chart illustrating a method of searching for a DNS server in an outernet, the method performed by a router where a DNS server is not registered, according to the present invention. First, a DNS search message is received from a subnet to which a router belongs in step **151**. The subnet includes a host, at least one router, or at least one DNS server, which is connected directly to the router. After step **151**, a hop limit for the DNS search message is decreased by a predetermined value in step **152**. Next, since a DNS server is not registered with the router, the router sends the DNS search message with the decreased hop limit to another router belonging to the subnet, in step **153**. This is repeated while increasing the hop limit until the DNS search message is transmitted to a router where a DNS server is registered.

[**0061**] **FIG. 16** is a flow chart illustrating a method of searching for a DNS server in an outernet, the method performed by a host, a DNS server, a router where the DNS server is registered, and a router where the DNS server is not registered. Referring to **FIG. 16**, in step **161**, a DNS search message is created and transmitted to a first subnet, to which a host belongs, so as to receive a response message to the DNS search message, and the DNS search message is transmitted to an outernet to which the host does not belong when a response message is not received. After step **161**, a DNS register message is created and transmitted to a second subnet, to which a DNS server belongs, to receive a response message thereof from a first router connected to the second subnet, and the DNS search message with respect to the DNS server is received from the first router and a response message thereof is sent to the first router, in step **162**. After step **162**, the DNS register message is received from the DNS server to register the DNS server with the first router, and the DNS search message is received from the second subnet to transmit the DNS search message to the registered DNS server, in step **163**. After step **163**, the DNS search message is received from a third subnet to which a second router belongs, and the DNS search message is transmitted along with a hop limit, which is decreased by a predetermined value, to a third router belonging to the third subnet, in step **164**.

[**0062**] **FIG. 17** is a view of one example of a DNS search message used in the present invention. The DNS search message is a modified one of a neighbor solicitation message prescribed in RFC 2463. The DNS search message adopts an ICMP type **135**, and is used to determine the address of a link layer of an adjacent node. Referring to **FIG. 17, a** global scope multicast address, e.g., FFOE:0::1, is defined in the field of a destination address. A code field of an ICMP header is set to 1 in the present invention, whereas it is set to 0 in a conventional DNS search message. If the code field is set to 1, the router decreases a hop limit by 1 and transmits the DNS search message with the decreased hop limit to the other routers, using multicast transrmission method.

[**0063**] **FIG. 18** is a view of another example of a DNS search message according to the present invention. The address of a DNS server is registered with a router belonging to a subnet, to which the DNS server also belongs, using a router solicitation message. The router manages lists of the addresses of DNS servers and sends a neighbor solicitation message to a DNS server upon receiving a message instructing to search for the DNS server. Referring to **FIG. 18**, global subnet anycast address is defined in a destination address field, and a code field of an ICMP header is set to 1 (the code field is set to 0 in a conventional DNS search message). If the code field is set to 1, the router decreases a hop limit by 1 and transmits the DNS search message with the decreased hop limit to the other routers. In the event that a router nearest to said router responds to DNS search message, a one-to-one communication is made between the DNS server and the closest router, using a unicast transmission method.

[**0064**] The present invention can be embodied as a computer readable code in a computer readable medium. Here, the computer readable medium may be any recording apparatus capable of storing data that can be read by a computer system, e.g., a read-only memory (ROM), a random access memory (RAM), a compact disc (CD)-ROM, a magnetic tape, a floppy disk, an optical data storage apparatus, and so on. Also, the computer readable medium may be a carrier wave that transmits data via the Internet, for example. The computer readable recording medium can be remotely installed in a computer system connected to a network, and stored and accomplished as a computer readable code by a distributed computing environment.

[**0065**] While this invention has been particularly shown and described with reference to preferred embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention as defined by the appended claims.

[**0066**] As described above, according to the present invention, a host creates a DNS search message and trans-

mits it to a subnet to which the host belongs so as to receive a response message to the DNS search message. If no response message is sent from the subnet, the DNS search message is again transmitted to an outernet to which the host does not belong. Therefore, when a DNS server is not connected to the subnet, it is possible to automatically search for a DNS server connected to an outernet. Further, when a DNS server does not respond to a DNS search message from a host, a hop limit is increased to resend the DNS search message, thereby preventing waste of bandwidth of network and easily detecting the closest DNS server.

What is claimed is:

1. An apparatus, which is included in a host, for searching for a DNS server in an outernet, comprising:

a subnet DNS searching unit for creating a DNS search message, transmitting the DNS search message to a subnet to which the host belongs, and receiving a response message to the DNS search message; and

an outernet DNS searching unit for transmitting the DNS search message to an outernet to which the host does not belong and receiving a response message to the DNS search message, when the subnet DNS searching unit fails to receive the response message.

2. The apparatus of claim 1, wherein the subnet comprises at least one router or at least one DNS server, connected directly to the host.

3. The apparatus of claim 1, wherein the outernet comprises at least one router or at least one DNS server, connected indirectly to the host.

4. The apparatus of claim 1, wherein the subnet DNS searching unit comprises:

a DNS search message creating unit for automatically creating an address of a transmitter in order to make the DNS search message;

a DNS search message transmission unit for multicast transmitting the DNS search message to each node of the subnet; and

a DNS search response message receiving unit for receiving a response message to the DNS search message from any node of the subnet.

5. The apparatus of claim 1, wherein the outernet DNS searching unit comprises:

a DNS search message transmission unit for repeatedly multicast transmitting the DNS search message to each node of the outernet until a response message to the DNS search message is sent from each node, when the subnet DNS searching unit fails to receive the response message; and

a DNS search response message receiving unit for receiving the response message from any node of the outernet.

6. The apparatus of claim 5, wherein the DNS search message transmission unit comprises:

a hop limit setting unit for increasing a currently set hop limit by a predetermined value whenever the outernet DNS searching unit fails to receive the response message, when the subnet DNS searching unit fails to receive the response message; and

a DNS search message repetition transmission unit for multicast transmitting the DNS search message to each node of the outernet based on the set hop limit until the DNS search response message receiving unit receives the response message.

7. An outernet DNS searching apparatus included in a DNS server, the apparatus comprising:

a DNS register message creating unit for creating a DNS register message with the address of a DNS server as the address of a transmitter;

a DNS register message transmission unit for transmitting the DNS register message to a subnet to which the DNS server belongs;

a DNS register response message receiving unit for receiving a response message to the DNS register message from a router belonging to the subnet;

a DNS search message receiving unit for receiving a DNS search message from the router; and

a DNS search response message transmission unit for transmitting a response message to the DNS search message to the router.

8. The apparatus of claim 7, wherein the subnet comprises a host or at least one router, connected directly to the DNS server.

9. The apparatus of claim 7, wherein the DNS register message transmission unit transmits the DNS register message to each node of the subnet, using an anycast transmission method.

10. An apparatus for searching for a DNS server in an outernet, the apparatus being included in a router where a DNS server is registered, the apparatus comprising:

a DNS register message receiving unit for receiving a DNS register message from a subnet to which the router belongs;

a DNS server registering unit for registering a DNS server related to the DNS register message with the router;

a DNS search message receiving unit for receiving a DNS search message from the subnet; and

a DNS search message DNS server transmission unit for transmitting the DNS search message to the registered DNS server.

11. The apparatus of claim 10, wherein the subnet comprises a host, at least one subnet router, or at least one DNS server, which is connected directly to the router.

12. An apparatus for searching for a DNS server in an outernet, the apparatus included in a router where a DNS server is not registered, the apparatus comprising:

a DNS search message receiving unit for receiving a DNS search message from a subnet to which the router belongs;

a hop limit decreasing unit for decreasing a hop limit for the DNS search message by a predetermined value; and

a DNS search message router transmission unit for transmitting the DNS search message with the decreased hop limit from another router belonging to the subnet.

13. The apparatus of claim 12, wherein the subnet comprises a host, at least one subnet router, or at least one DNS server, connected directly to the router.

14. An apparatus for searching for a DNS server in an outernet, comprising:

a first outernet DNS searching unit included in a host, the first outernet DNS searching unit creating a DNS search message, transmitting the DNS search message to a first subnet, to which the host belongs, so as to receive a response message to the DNS search message, and transmitting the DNS search message to an outernet, to which the host does not belong, when the response message is not received from the first subnet;

a second outernet DNS searching unit included in a DNS server, the second outernet DNS searching unit creating a DNS register message, transmitting the DNS register message to a second subnet to receive a response message to the DNS register message from a first router belonging to the second subnet, receiving a second DNS search message related to the DNS server from the first router, and sending a second response message to the second DNS search message to the first router;

a third outernet DNS searching unit included in a router where a DNS server is registered, the third outernet DNS searching unit receiving a second DNS register message from the DNS server, registering the DNS server with the router, receiving a third DNS search message from the second subnet, and transmitting the third DNS search message to the registered DNS server; and

a fourth outernet DNS searching unit included in a router where a DNS server is not registered, the fourth DNS searching unit receiving a fourth DNS search message from a third subnet, transmitting the fourth DNS search message with a hop limit to a third router belonging to the third subnet, to which a second router also belongs, and decreasing the hop limit by a predetermined value.

15. A method of searching for a DNS server in an outernet, comprising:

creating a DNS search message, transmitting it to a subnet to which a host belongs, and receiving a response message to the DNS search message; and

transmitting the DNS search message to an outernet to which the host does not belong when the response message is not received from the subnet, and receiving the response message from the outernet.

16. The method of claim 15, wherein the subnet comprises at least one router or at least one DNS server, connected directly to the host.

17. The method of claim 15, wherein creating a DNS search message comprises:

automatically creating the address of a transmitter and creating the DNS search message;

multicast transmitting the DNS search message to each node of the subnet; and

receiving a response message to the DNS search message from any node of the subnet.

18. The method of claim 15, wherein the outernet comprises at least one router or at least one DNS server, connected indirectly to the host.

19. The method of claim 15, wherein transmitting the DNS search message to the outernet comprises:

repeatedly multicast transmitting the DNS search message to each node of the outernet until the response message to the DNS search message is received, when the response message is not received; and

receiving the response message from any node of the outernet.

20. The method of claim 19, wherein repeatedly multicast transmitting the DNS search message comprises:

increasing a currently set hop limit by a predetermined value when the response message to the DNS search message is not received; and

repeatedly multicast transmitting the DNS search message to each node of the outernet based on the set hop limit until the response message is received.

21. A method of searching for a DNS server in an outernet, the method performed by the DNS server, the method comprising:

creating a DNS register message with the address of a DNS server as the address of a transmitter;

transmitting the DNS register message to a subnet to which the DNS server belongs;

receiving a response message to the DNS register message from a router belonging to the subnet;

receiving the DNS search message related to the DNS server from the router; and

transmitting a response message to the DNS search message to the router.

22. The method of claim 21, wherein the subnet comprises a host or at least one router, connected directly to the DNS server.

23. The method of claim 21, wherein when transmitting the DNS register message to the subnet, the DNS register message is anycast transmitted to each node of the subnet.

24. A method of searching for a DNS server in an outernet, the method performed by a router where a DNS server is registered, the method comprising:

receiving a DNS register message from a subnet to which a router belongs;

registering a DNS server related to the DNS register message to the router;

receiving a DNS search message from the subnet; and

transmitting the DNS search message to the registered DNS server.

25. The method of claim 24, wherein the subnet comprises a host, at least one router, or at least one DNS server, connected directly to the router.

26. A method of searching for a DNS server in an outernet, the method performed by a router where a DNS server is not registered, the method comprising:

receiving a DNS search message from a subnet to which a router belongs;

decreasing a hop limit for the DNS search message by a predetermined value; and

transmitting the DNS search message with the decreased hop limit to another router belonging to the subnet.

27. The method of claim 26, wherein the subnet comprises a host, at least one router, or at least one DNS server, connected directly to the router.

28. A method of searching for a DNS server in an outernet, comprising:

creating a DNS search message, transmitting the DNS search message to a first subnet, to which a host belongs, so as to receive a response message to the DNS search message, and transmitting the DNS search message to an outernet, to which the host does not belong, so as to receive the response message;

creating a DNS register message, transmitting the DNS register message to a second subnet, to which a DNS server belongs, receiving a response message to the DNS register message from a first router belonging to the second subnet, receiving a DNS search message related to the DNS server from the first router, and transmitting a response message to the DNS search message to the first router;

receiving the DNS register message from the DNS server to register the DNS server to the first router, receiving a DNS search message from the second subnet, and transmitting the DNS search message to the registered DNS server; and

receiving a DNS search message from a third subnet, to which a second router belongs, transmitting the DNS search message with a hop limit to a third router, and decreasing the hop limit by a predetermined value.

29. A computer program product for searching for a DNS server in an outernet, comprising:

software instructions for enabling the computer to perform predetermined operations, and a computer readable medium bearing the software instructions;

wherein the predetermined operations include:

creating a DNS search message, transmitting it to a subnet to which a host belongs, and receiving a response message to the DNS search message; and

transmitting the DNS search message to an outernet to which the host does not belong when the response message is not received from the subnet, and receiving the response message from the outernet.

30. The computer program product of claim 29, wherein the subnet comprises at least one router or at least one DNS server, connected directly to the host.

31. The computer program product of claim 29, wherein creating a DNS search message comprises:

automatically creating the address of a transmitter and creating the DNS search message;

multicast transmitting the DNS search message to each node of the subnet; and

receiving a response message to the DNS search message from any node of the subnet.

32. The computer program product of claim 29, wherein the outernet comprises at least one router or at least one DNS server, connected indirectly to the host.

33. The computer program product of claim 29, wherein transmitting the DNS search message to the outernet comprises:

repeatedly multicast transmitting the DNS search message to each node of the outernet until the response message to the DNS search message is received, when the response message is not received; and

receiving the response message from any node of the outernet.

34. The computer program product of claim 33, wherein repeatedly multicast transmitting the DNS search message comprises:

increasing a currently set hop limit by a predetermined value when the response message to the DNS search message is not received; and

repeatedly multicast transmitting the DNS search message to each node of the outernet based on the set hop limit until the response message is received.

35. A computer program product for searching for a DNS server in an outernet, the computer program product in the DNS server, comprising:

software instructions for enabling the computer to perform predetermined operations, and

a computer readable medium bearing the software instructions;

wherein the predetermined operations include:

creating a DNS register message with the address of a DNS server as the address of a transmitter;

transmitting the DNS register message to a subnet to which the DNS server belongs;

receiving a response message to the DNS register message from a router belonging to the subnet;

receiving the DNS search message related to the DNS server from the router; and

transmitting a response message to the DNS search message to the router.

36. The computer program product of claim 35, wherein the subnet comprises a host or at least one router, connected directly to the DNS server.

37. The computer program product of claim 35, wherein when transmitting the DNS register message to the subnet, the DNS register message is anycast transmitted to each node of the subnet.

38. A computer program product for searching for a DNS server in an outernet, the computer program product in a router where a DNS server is registered, comprising:

software instructions for enabling the computer to perform predetermined operations, and

a computer readable medium bearing the software instructions;

wherein the predetermined operations include:

receiving a DNS register message from a subnet to which a router belongs;

registering a DNS server related to the DNS register message to the router;

receiving a DNS search message from the subnet; and

transmitting the DNS search message to the registered DNS server.

39. The computer program product of claim 38, wherein the subnet comprises a host, at least one router, or at least one DNS server, connected directly to the router.

40. A computer program product for searching for a DNS server in an outernet, the computer program product in a router where a DNS server is not registered, comprising:

software instructions for enabling the computer to perform predetermined operations, and

a computer readable medium bearing the software instructions;

wherein the predetermined operations include:

receiving a DNS search message from a subnet to which a router belongs;

decreasing a hop limit for the DNS search message by a predetermined value; and

transmitting the DNS search message with the decreased hop limit to another router belonging to the subnet.

41. The computer program product of claim 40, wherein the subnet comprises a host, at least one router, or at least one DNS server, connected directly to the router.

42. A computer program product for searching for a DNS server in an outernet, comprising:

software instructions for enabling the computer to perform predetermined operations, and

a computer readable medium bearing the software instructions;

wherein the predetermined operations include:

creating a DNS search message, transmitting the DNS search message to a first subnet, to which a host belongs, so as to receive a response message to the DNS search message, and transmitting the DNS search message to an outernet, to which the host does not belong, so as to receive the response message;

creating a DNS register message, transmitting the DNS register message to a second subnet, to which a DNS server belongs, receiving a response message to the DNS register message from a first router belonging to the second subnet, receiving a DNS search message related to the DNS server from the first router, and transmitting a response message to the DNS search message to the first router;

receiving the DNS register message from the DNS server to register the DNS server to the first router, receiving a DNS search message from the second subnet, and transmitting the DNS search message to the registered DNS server; and

receiving a DNS search message from a third subnet, to which a second router belongs, transmitting the DNS search message with a hop limit to a third router, and decreasing the hop limit by a predetermined value.

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